



Review

Epidemiology of prostate cancer in India

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ABSTRACT

Data from national cancer registries shows that incidence of certain cancers are on rise in India. The cancers which are showing significant increase in incidence rates include prostate, mouth and kidney among male population, corpus uteri, breast and thyroid among female population and lung cancer in both male and female populations. In the present review article we have focused on epidemiology of prostate cancer in Indian subcontinent in terms of incidence, survival, and mortality etc. The article presents the incidence rates, mortality and trends over time for prostate cancer as the data collected from national population based cancer registries. Prostate is the second leading site of cancer among males in large Indian cities like Delhi, Kolkatta, Pune and Thiruvananthapuram, third leading site of cancer in cities like Bangalore and Mumbai and it is among the top ten leading sites of cancers in the rest of the population based cancer registries (PBCRs) of India. The PBCRs at Bangalore (Annual Percentage Change: 3.4%), Chennai (4.2%), Delhi (3.3%), Mumbai (0.9%) and Kamrup Urban District (11.6%) recorded a statistically significant increasing trend in incidence rates over time.

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Introduction

Prostate cancer (PCa) is the second most common cause of cancer and the sixth leading cause of cancer death among men worldwide. The worldwide PCa burden is expected to grow to 1.7 million new cases and 499 000 new deaths by 2030 simply due to the growth and aging of the global population (Ferlay et al., 2010).

Prostate cancer has become a major health problem in industrialized world during the last decades of the 20th century contributing to three fourth of the registered cases across the globe (Perin, 2001). Incidence rates of prostate cancer vary by more than 25 fold worldwide, the highest rates being in Australia/New Zealand (104.2/100,000), Western and Northern Europe, North America, largely because the practice of PSA has become widespread in those regions. Although incidence rates of prostate cancer are considered low in Asian and North African countries, ranging from 1 to 9/100,000 persons (Perin, 2001), demographic and epidemiological transitions in developing countries like India have shown an increasing trend in the burden of various cancer cases including prostate cancer.

Previously it was thought, that prevalence of prostate cancer in India is far lower as compared to the western countries but with the increased migration of rural population to the urban areas, changing life styles, increased awareness, and easy access to medical facility, more cases of prostate cancer are being picked up and it is coming to the knowledge that we are not very far behind the rate from western countries. The cancer registries are reporting some new information and we can see that we are going to face a major increase in cancer incidences in the coming years. The population of India in general and that of the areas covered by the registries in particular, have displayed rapid changes in life styles, dietary practices and socio-economic milieu. Diagnostic and detection technologies have improved and more of the population has not only access, but can also afford the same.

The marked disparity between prevalence and incidence rates of prostate cancer, on the one hand, and morbidity and mortality rates, on the other, has led some to conclude that many prostate cancers are harmless and perhaps would better be left undetected. Nevertheless, if the present trends of increasing life expectancy continue, given the current age-specific incidence, morbidity, and mortality rates of prostate cancer, this disease will become a far greater public health problem in the future.

Correct and complete knowledge of epidemiology is very important in helping policy makers and concerned authorities to plan and formulate sound cancer control strategies based on scientific and empirical bases. This review article aims to bring together the information that is scattered in bits and parts in different Indian registries to see a broader picture of prostate cancer epidemiology in Indian subcontinent.

Methods

Information for this review article was obtained from multiple sources. Percentage of relative proportion of prostate cancer burden in different cities of India and their respective Crude Rate (CR) and Age Adjusted Rate (AAR) per 100,000 populations were derived from the 2009–2011 National Cancer Registry Program reports, from twenty five population-based cancer registries (PBCRs) across India including Bangalore, Barshi rural and expanded, Bhopal, Chennai, Delhi, Mumbai, Ahmedabad rural and urban, Aurangabad, Nagpur, Pune, Wardha, Kolkata, Kollam, Thiruvananthapuram, and North-East (Cachar District, Aizawl District, Dibrugarh District, Kamrup Urban District, Manipur State, Mizoram State, Imphal West District, Sikkim State, Meghalaya and Tripura State, Nagaland). (Anon., 2013a).

Data for trends over time for prostate cancer and for estimating the projection of burden of prostate cancer was taken from National Cancer Registry Program report of time trends in cancer incidence rates (1982–2010) for 13 Population Based Cancer Registries including Bangalore, Bhopal, Chennai, Delhi, Mumbai, Barshi, Thiruvananthapuram, Dibrugarh, Kamrup Urban District, Imphal West District, Ahmedabad Rural

District and the states of Mizoram and Sikkim. The report also provided some information on trends in incidence rates at Kolkata, Kollam, Ahmedabad Urban, Pune, Aurangabad and Nagpur for 5–6 years (Anon., 2013b).

National capital data was collected from various reports of Delhi PBCR for the years 1990–2011 (Verma & Tyagi, 1998–1999; Raina et al., 2001–2003; Julka et al., 2006–2007; Julka et al., 2008–2009).

Besides this, many review articles were screened to strain the data regarding epidemiology of prostate cancer in India and in different countries worldwide.

Burden of prostate cancer in different population based cancer registries

The most recent Population Based Cancer Registries (PBCRs) of different cities for the time period (2008–2011) shows that prostate cancer has ranked among top ten leading sites of cancer in many cities including Bangalore, Barshi, Bhopal, Chennai, Delhi, Mumbai, Kamrup, Ahmedabad, Kolkata, Kollam, Nagpur, Pune, Trivandram and Wardha. (Table 1, Fig. 1) The leading sites of cancer were decided on the basis of proportion relative to all sites of cancer or in other words based on crude incidence rates (Anon., 2013a).

Prostate is the second leading site of cancer for four PBCRs namely Delhi, Kolkata, Nagpur and Thiruvananthapuram. It is also evident from the table that prostate cancer incidence are highest in metro cities like Delhi (2nd most common cancer), Mumbai (3rd most common cancer), Kolkatta (2nd most common cancer), Chennai (4th most common cancer), Bangalore (3rd most common cancer) and Pune (2nd most common cancer) as compared to the smaller cities like Kollam, Bhopal, Nagpur and Wardha. As far as different regions of India are concerned, prostate cancer has ranked among top ten in all the regions like north (Delhi–2nd most common), south (Trivandram–2nd most common), east (Kolkatta–2nd most common) and west (Mumbai–3rd most common).

The incidence of PCa is relatively low in some states like Gujrat (Ahmedabad and Wardha PBRCs) and Madhya Pradesh (Bhopal PBCR). But the incidence of Prostate cancer is lowest in north east region of India. Northeast India is the eastern-most region of India connected to East India via a narrow corridor squeezed between Nepal and Bangladesh. It comprises the contiguous Seven Sister States—Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland and Tripura and the Himalayan state of Sikkim. PBCRs from Assam state (Cachar District and Dibrugarh District) shows absence of prostate cancer among top ten leading site of cancers except Kamrup district where it is 6th leading site of cancer. PBCRs from Manipur state, Mizoram State, Sikkim state, Meghalaya state, Tripura state and Nagaland show that PCa is not among the top ten leading site of cancer in these states.

Table 1

Table showing relative proportion (&) of prostate cancer incidence, rank among top ten leading sites of all cancers, respective crude rate (CR) and age adjusted rate (AAR) per 100,000 population for different population based cancer registries of India.

Ser No.	City	Relative proportion (%)	Rank	Respective crude rate (CR)	Age adjusted rate (AAR) per 100,000 population	Duration
1	Bangalore	6.7%	3rd	5.3	8.9	2008–2009
2	Barshi rural	4.4	7th		1.9	2009–2010
3	Barshi expanded	5.5%	4th	2.0	1.9	2009
4	Bhopal	5.2%	5th	3.8	6.6	2009–2010
5	Chennai	5.9%	4th	6.3	7.0	2009
6	Delhi	6.8%	2nd	5.2	10.7	2008–2009
7	Mumbai	6.8%	3rd	4.8	7.8	2009–2010
8	Kamrup Urban District	4.6%	6th		11.1	2009–2011
9	Ahmedabad Rural District	2.9%	7th		2.6	2009–2010
10	Ahmedabad Urban District	3.5%	7th		5.4	2009–2010
11	Kolkata	7.5%	2nd	7.6	6.9	2008–2009
12	Kollam	4.8%	5th	6.2	5.7	2009–2010
13	Nagpur	3.2	9th		3.4	2008–2009
14	Pune	8.6	2nd	4.5	7.2	2009–2010
15	Thiruvananthapuram	6.4	2nd	9.1	8.5	2009–2011
16	Wardha	2.9	9th		2.0	2010–2011

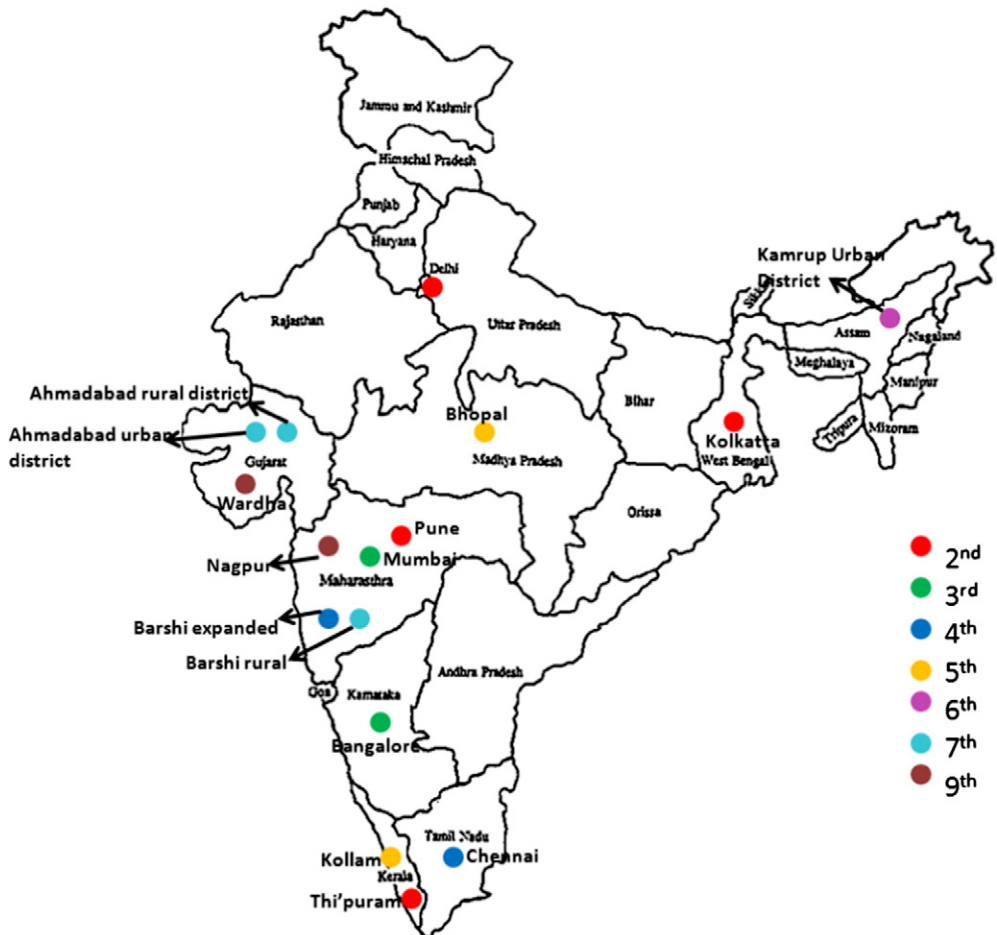


Fig. 1. A map of India showing the rank of prostate cancer among top ten leading sites of all cancers, for different population based cancer registries of India.

Trends over time for prostate cancer

The report on “Time Trends in Cancer Incidence Rates from 1982 to 2010” spanning three decades including data from 13 different PBCRs shows that prostate cancer has shown statistically significant increase in incidence rates. (Figs. 2 and 3).

The PBCRs at Bangalore (APC: 3.4%), Chennai (4.2%), Delhi (3.3%), Mumbai (0.9%) and Kamrup Urban District (11.6%) recorded a statistically significant increasing trend in incidence rates over time. Details are given in Table 2. In Bangalore registry the APC was 6.3% between 1997 and 2009 (Anon., 2013b).

Trends over time in AARs

The age adjusted rates (AARs) for different PBCRs show a consistent increase over the time (1982–2010) for all PBCRs. (Figs. 2 and 3) Table 3 gives the actual values of the AARs for the five older PBCRs (Bangalore, Bhopal, Chennai, Delhi and Mumbai) for each calendar year with statistical significance using slope (b) and p-value based on simple linear regression. In addition, the corresponding statistical significance of trends based on annual average AARs for three and five calendar year groupings are also provided. Table 4 shows the actual values of the AARs for the two very recent PBCRs (Kamrup urban district and Thi'Puram) for each

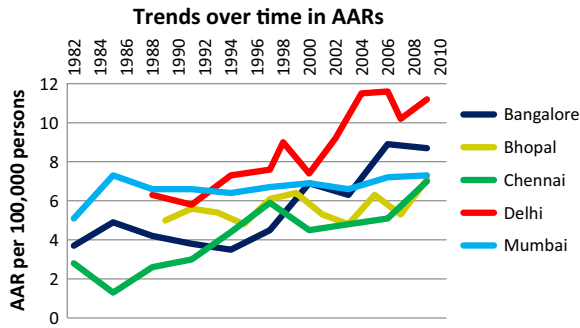


Fig. 2. Graph showing trends over time in age adjusted rates (AARs) for five population based cancer registries.

calendar year. (Fig. 3) Statistical significance using slope (b) and p-value based on simple linear regression are given for recent PBCRs also. For the newer PBCRs, the three year moving average is used (as the number of calendar years of registry operation is not as yet sufficient to draw the three and five year trends as for the older PBCRs) and these values are given in the table. (Table 4)

Trends over time based on value of join point AARs with annual percent change (APC)

The Joinpoint Regression data for the same PBCRs as in Tables 3 and 4 is shown in Tables 5 and 6 respectively. These tables (with expected AAR for each calendar year) are also provided with Annual Percentage Change (APC) and statistical significance as appropriate. The five year annual average AAR graph for older PBCRs is given. For both older and newer PBCRs, the Joinpoint Regression Model Graphs have been depicted. (Figs. 4 and Fig. 5)

Among the five PBCR data shown in Table 5, the highest rate of annual percentage change is being faced by Chennai (4.1), followed by Bangalore (3.36) and Delhi (3.33) as shown in Table 5.

Data from new PBCRs of Kamrup urban district and Thi'puras also show a sharp increase in APC (Table 6).

Recent PBCRs

The data from the new PBCRs, viz., Ahmadabad Urban, and Bhopal (for the period 2005/06–2009/10) also show a statistically significant rise in incidence rates of prostate cancer over time. The annual percentage change for Ahmadabad Urban is 24.1% and for Bhopal its 1.7% (Anon., 2013b).

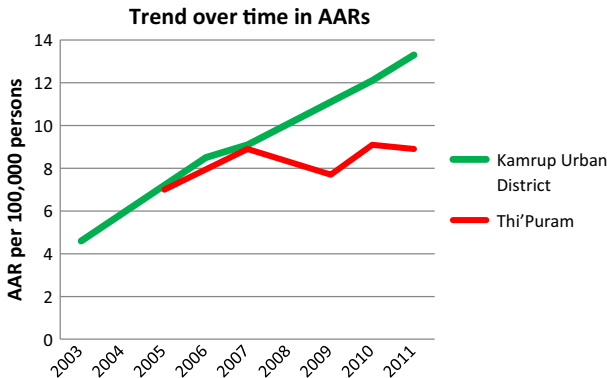


Fig. 3. Graph showing trends over time in age adjusted rates (AARs) for two recent population based cancer registries.

Table 2

Table showing annual percentage change (APC) for different PBCRs.

Ser No.	PBCR	Annual percentage change (APC)	Duration
1	Bangalore	3.4%	1982–2009/10
2	Chennai	4.2%	1982–2009/10
3	Delhi	3.3%	1988–2009/10
4	Mumbai	0.9%	1982–2009/10
5	Kamrup Urban District	11.6%	2003–2010/11

Projection of burden of prostate cancer

Cancer projections are useful especially in a developing country like India, to plan and prioritize health care services that would include both diagnostic and treatment facilities. It therefore aids in the formulation of government policies and budget allocation. The numbers of cancers by place and type also constitute baseline information and act as indicators of cancer control.

Projection of cancer burden means a systematic way of the prediction of the number of cancer cases for a specific site and for a specified period of time. One way could be to use the change in incidence rates over

Table 3

Trends over time in AARs for five PBCRs.

Year	Bangalore	Bhopal	Chennai	Delhi	Mumbai
1982	3.7		2.8		5.1
1983	2.9		2.0		5.4
1984	3.7		1.2		6.2
1985	4.9		1.3		7.3
1986	4.4		2.7		5.3
1987	4.9		2.3		6.2
1988	4.2	1.9	2.6	6.3	6.6
1989	6.2	5.0	3.1	5.8	5.6
1990	5.3	6.3	2.6	5.6	7.1
1991	3.8	5.6	3.0	5.8	6.6
1992	5.4	4.3	3.7	6.5	7.2
1993	4.1	5.4	2.5	6.8	6.9
1994	3.5	3.8	4.4	7.3	6.4
1995	4.0	4.8	5.1	5.9	6.4
1996	4.1	5.9	4.6	5.5	7.9
1997	4.5	6.1	5.9	7.6	6.7
1998	4.7	7.6	3.7	9.0	7.2
1999	5.5	6.4	4.3	7.8	7.7
2000	6.9	6.9	4.5	7.4	6.9
2001	6.6	5.3	3.9	7.6	6.7
2002	6.7	6.2	3.4	9.2	6.0
2003	6.3	4.8	4.8	7.0	6.6
2004	6.7	5.7	5.2	11.5	6.4
2005	8.0	6.3	4.8	9.4	7.3
2006	8.9	4.9	5.1	11.6	7.2
2007	10.1	5.3	4.8	10.2	7.5
2008	9.2	5.0	3.8	10.1	7.7
2009	8.7	7.1	7.0	11.2	7.3
2010		6.1			8.2
Slope (b)	0.194	0.071	0.134	0.264	0.059
p-Value	0.000	0.059	0.000	0.000	0.000
3 year trend slope (b)	0.185	0.066	0.138	0.263	0.059
p-Value	0.005	0.140	0.000	0.000	0.003
5 year trend slope (b)	0.208	0.062	0.132	0.268	0.057
p-Value	0.012	0.208	0.002	0.001	0.027

Table 4
Trends over time in AARs for two recent PBCRs.

Year	Kamrup Urban District	Thi'Puram
2003	4.6	
2004	8.6	
2005	3.8	7.0
2006	8.5	6.3
2007	9.1	8.9
2008	7.6	6.4
2009	7.8	7.7
2010	12.1	9.1
2011	13.3	8.9
Slope (b)	0.875	0.353
p-Value	0.013	0.132
3 year moving average slope (b)	0.774	0.274
p-Value	0.001	0.058

time and derive the expected or projected incidence rate and apply the same to the projected population of that year. Anon. (2013b) Table 7 shows the number of projected cases of prostate cancer for selected time periods for India.

Table 5
Trends over time based on value of joinpoint AARs with annual percent change.

Year	Bangalore	Bhopal	Chennai	Delhi	Mumbai
	JP1	JP1	JP0	JP0	JP0
1982	4.0		2.0		5.9
1983	4.1		2.1		6.0
1984	4.1		2.2		6.0
1985	4.1		2.3		6.1
1986	4.2		2.4		6.1
1987	4.2		2.5		6.2
1988	4.2	2.3	2.6	5.5	6.3
1989	4.3	3.5	2.7	5.7	6.3
1990	4.3	5.5	2.8	5.9	6.4
1991	4.3	5.5	2.9	6.1	6.4
1992	4.4	5.5	3.0	6.3	6.5
1993	4.4	5.6	3.1	6.5	6.5
1994	4.4	5.6	3.3	6.7	6.6
1995	4.5	5.6	3.4	6.9	6.7
1996	4.5	5.6	3.6	7.1	6.7
1997	4.8	5.6	3.7	7.4	6.8
1998	5.1	5.6	3.9	7.6	6.8
1999	5.4	5.7	4.0	7.9	6.9
2000	5.8	5.7	4.2	8.1	7.0
2001	6.1	5.7	4.4	8.4	7.0
2002	6.5	5.7	4.5	8.7	7.1
2003	6.9	5.7	4.7	9.0	7.1
2004	7.4	5.8	4.9	9.3	7.2
2005	7.8	5.8	5.1	9.6	7.3
2006	8.3	5.8	5.3	9.9	7.3
2007	8.8	5.8	5.6	10.2	7.4
2008	9.4	5.8	5.8	10.6	7.5
2009	10.0	5.8	6.0	10.9	7.5
2010		5.9			7.6
APC0	3.36^a	1.74^a	4.15^a	3.33^a	0.89^a
APC1	0.79	55.75	–	–	–
APC2	6.29^a	0.33	–	–	–

Values of years where a shift in trend observed is highlighted.

^a Bold represents significant APC (p < 0.05) values.

Table 6
Trends over time based on the value of joinpoint AARs with annual percent change for two recent PBRCs.

Year	Kamrup Urban District	Thi'puram
	JPO	JPO
2003	5.1	
2004	5.6	
2005	6.3	6.7
2006	7.0	7.0
2007	7.8	7.3
2008	8.7	7.7
2009	9.8	8.0
2010	10.9	8.4
2011	12.2	8.8
APC0	11.62^a	4.79
APC1	–	
APC2	–	

Values of years where a shift in trend observed is bold.
^a Represents significant APC ($p < 0.05$) values.

Delhi cancer registry

Delhi is a metropolitan city and is capital of Indian subcontinent. This city is inhabited by a mixed population migrated from different states of India and from different countries. Therefore population of Delhi consists of people with different genetic backgrounds and different lifestyles.

Delhi Cancer Registry is a Population Based Cancer Registry and collects data on resident cancer patients from all over Delhi. The sources of cancer data for Delhi Cancer Registry are more than 160 major Government hospital centers, 250 private hospitals and nursing homes and Department of Vital Statistics of New Delhi Municipal Committee and Delhi Municipal Corporation (Verma & Tyagi, 1998–1999).

The cancer registry covers an urban area of 891.09 km² of Delhi Municipal Corporation, New Delhi Municipal Committee and Delhi Cantonment and 29 census towns with an estimated population of 13,088,133 (Males: 718,6306, Females: 5,901,827) as per 2001 census (Verma & Tyagi, 1998–1999).

Table 8 shows the percentage distribution of prostate cancer cases in Delhi and their rank among top five anatomical sites of cancers along with their crude incidence rate, world age adjusted incidence rates and truncated rates for different time periods. (Verma & Tyagi, 1998–1999; Raina et al., 2001–2003; Julka et al., 2006–2007; Julka et al., 2008–2009) The table shows that prostate cancer is the second leading site of cancers in Delhi and the incidence rates are quite higher in Delhi compared to other parts of India and it is rapidly increasing.

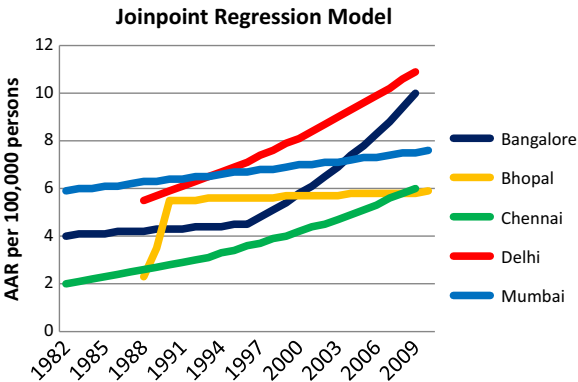


Fig. 4. Graph showing trends over time in age adjusted rates (AARs) for Joinpoint regression model for five population based cancer registries.

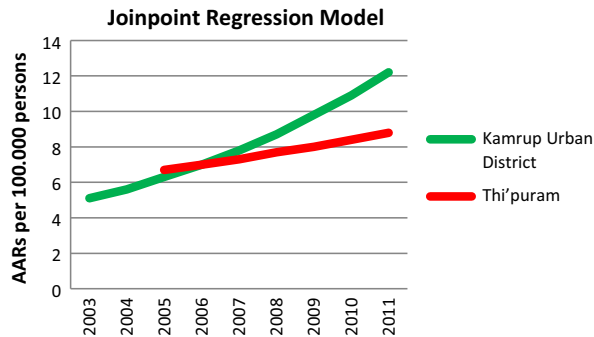


Fig. 5. Graph showing trends over time in age adjusted rates (AARs) for Joinpoint regression model for two recent population based cancer registries.

The mortality rates because of prostate cancers are given in Table 9 (Verma & Tyagi, 1998–1999; Raina et al., 2001–2003; Julka et al., 2006–2007; Julka et al., 2008–2009).

Conclusion

We have reviewed the epidemiology (incidence, survival, and mortality) of prostate cancer across different PBCRs in India and highlighted certain important facts. Prostate is the second leading site of cancer among males in large Indian cities like Delhi, Kolkatta, Pune and Thi'puram, third leading site of cancer in cities like Bangalore and Mumbai and it is among the top ten leading sites of cancers in the rest of the PBCRs of India. The data shows that almost all regions of India are equally affected by this cancer. The incidence rates of this cancer are constantly and rapidly increasing in all the PBCRs. The cancer projection data shows that the number of cases will become doubled by 2020.

Delhi Cancer registry shows cancer of the prostate is the second most frequently diagnosed cancer among men in Delhi accounting for about 6.78% of all malignancies (2008–2009). The annual age adjusted (world population) incidence rate of prostate cancer in Delhi was 10.66 (2008) (Julka et al., 2008–2009) per 100,000 which is higher than South-East Asia (8.3) and Northern Africa (8.1) but lower than Northern America (85.6), Southern Europe (50.0) and Eastern Europe (29.1) and it is comparable to Western Asia (13.8) (Center et al., 2012).

Table 7
Projected cases of prostate cancer for selected time periods (2013, 2014, 2015 and 2020).

ICD-10	Site name	2013	2014	2015	2020
C61	Prostate	35,029	37,055	39,200	51,979

Table 8
Incidence rates of prostate cancers in Delhi for different time periods.

Ser No.	Year	Rank in top five leading sites of cancer	Percentage distribution	Crude incidence rate	World age adjusted incidence rates	Standard error (SE)	Truncated (35–64 years) incidence rates
1	1997–98	3	5.33%	3.90	8.53	0.39	6.75
2	2001–2003	3	5.28%	3.8	8.0	0.28	7.0
4	2006–2007	2	7.03%	5.5	10.9	0.10	8.7
5	2008–2009	2	6.78%	5.2	10.66	0.34	8.5

Table 9

Mortality rates of prostate cancers in Delhi for different time periods.

Ser No.	Year	Relative proportion	Crude rate	Age adjusted rate	Standard error (SE)	Truncated rate
1	2001–2003	3.01%	0.3	0.6	0.07	0.5
2	2006–2007	3.53%	0.3	0.6	0.09	0.6
3	2008–2009	3.70%	0.4	0.8	0.09	0.5

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